

ANNUAL REPORT

FOR

FY 1991

NASA / AMES SIMLAB

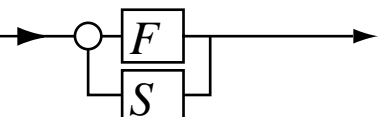
PREPARED BY:



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ASSISTANT CHIEF (OPERATIONS)

AUGUST 1991

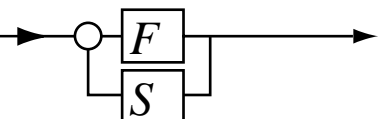
FLIGHT SYSTEMS & SIMULATION RESEARCH DIVISION



INTRODUCTION

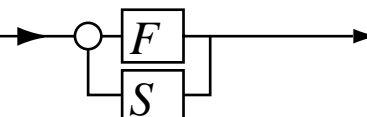
This is a Fiscal Year 91 Annual Report from the NASA/Ames Simulation Laboratories (SimLab), of the Flight Systems and Simulation Research Division.

This document is intended to report to our customers and management on the SimLab events of 1991, including a summary of the simulations performed in the facilities.



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EXECUTIVE SUMMARY

FY91 was a year of redirection in SimLab. Prior (FY90) budget cuts and associated staff layoffs activated a serious SimLab strategy planning process. This was essential to deal with the significant backlog of replacement needs in order to rebuild our capabilities and re-establish the integrity of the facilities.

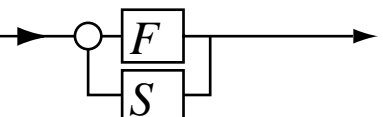
The five-year strategy developed was based on striking a new balance between operations, facility integrity and capability replacement. This will be done by phasing down operational levels (and support service contract manpower costs), thereby developing a funding wedge for the most urgent needs. The strategy was developed in the latter part of FY90, presented to and approved by management up to Code RC in headquarters, and implemented at the beginning of FY91.

In prior years, up to eighteen different simulation investigations would be conducted in a year on the VMS system. In FY91 this dropped to 14, and in FY92, 13 investigations are scheduled.

This has enabled SimLab to order and acquire, on a lease-to-own plan, a new VAX 9000 host computer, place orders for critically needed replacement out-the-window monitors for interchangeable cabs, and acquire other urgently needed replacement equipment.

The fourteen simulation investigations in the VMS this year include:

- Shuttle Approach & Landing (Sep. '90 & May '91)
- Civil Tilt Rotor III (CTR III)
- Visual / Motion Synchrony (VISMOSYNC)
- National Advanced Driving Simulator (NADS)
- Rotorcraft Air-To-Air Combat (RATAC)
- Enhanced Symbology, Pilot Night Vision System (ESPNVS)
- Terrain Following / Terrain Avoidance (TFTA/STAR)
- RASCAL
- STOVL
- VSRA & YAV8B
- UH-60 SCAS
- Simulation Validation 2 (SIMVAL 2)



FACILITY SUMMARY

SIMLAB STRATEGIC PLANNING:

FY91 was a year of redirection in SimLab. Prior (FY90) budget cuts and associated staff layoffs stimulated a serious SimLab strategy planning process. This was essential to deal with the significant backlog of replacement needs in order to rebuild our capabilities and reestablish the integrity of the facilities.

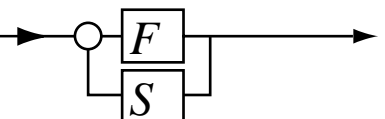
In the summer prior to the start of FY91, the two SimLab Branch Chiefs and the Assistant Division Chief (Operations), started an in-depth process of evaluating the status of SimLab, and developing a strategy for the future.

The state of many simulation systems in the lab was either obsolete, or inadequate to meet the needs of the research. We had a backlog of severe integrity/ capability replacement needs, and we were not spending sufficient budget on these needs. In fact, we had stopped all spending in FY90, due to budget cuts.

With the exception of the AD-100 computer acquired in 1988, our realtime mainframe computers were from six to twelve years old. Our computer-generated imagery (CGI) systems were six and twelve years old, and totally inadequate for the research needs. The Heads-Up, and Heads-Down Display (HUD/HOD) systems graphics generators were 16 years old, and the computer network and video switching network were of similar vintage. We concluded that we must balance future operational levels against integrity/ capability replacements to maintain the facilities as world class research tools for the NASA and nation's programs that depend on the capability of SimLab.

We also concluded that we could expect additional help on major cost items only, and that all other facility capability improvements must be met through the existing budgets.

The five-year strategy developed was based on striking this new balance between operations, facility integrity and capability replacement. This will be done by phasing down operational levels (and support service contract manpower costs), thereby developing a funding wedge for the most urgent needs.



SIMLAB STRATEGIC PLANNING: (Cont'd)

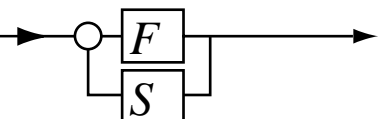
SimLab management had imposed a hiring freeze on our support contractors over a year earlier, and was managing attrition/ hiring on a case-by-case basis, based on criticality of need. It was decided to continue this process, a controlled attrition, based on that experience. We had sufficient data on the expected attrition rate to forecast staff levels and operational levels.

The strategy was developed in the latter part of FY90, presented to and approved by Center Management and Headquarters Code RC, and implemented at the beginning of FY91.

As FY91 has progressed, this funding/operational strategy has worked. We have currently reduced the level of operational simulation investigations to 14, and are scrutinizing the schedule to reduce it further. We have notified two other requesters that we cannot accommodate their requests for this year (TFTA and Tri-Service Symbology).

The funding plan for restoring capability/integrity to SimLab has been implemented as presented earlier. We have acquired a VAX9000 and a VAX4000 host computers. The VAX9000 is installed, accepted and undergoing integration into the network. First operational sim is scheduled for October 1991. The VAX4000 was integrated immediately, and performed an operational Shuttle Orbiter sim in May '91. Four new ICAB out-the-window-visual monitors were ordered, and will be delivered within 90 days. These are expensive (\$40K) 27-inch monitors, by necessity of hardened construction to withstand the vibration and acceleration of the motion system.

As part of this strategic process, we developed a plan to solicit support from the Space Shuttle program for the purpose of acquiring a modern replacement computer-generated-imagery (CGI) system for VMS. Early in May, Ames Associate Director Steve Hawley and Tony Cook briefed Leonard Nicholson, Shuttle Program Deputy Director on the need for a modern CGI system to ensure continued high-reliability use of the Ames VMS for Shuttle. The briefing was well received and the response was favorable. Currently, the shuttle program is working the prospect of providing an ESIG 3000 CGI for VMS out of the JSC contract options with Evans & Sutherland. SimLab is cautiously optimistic, but aware that this prospect may fall victim to space station funding problems.



SIMLAB STRATEGIC PLANNING: (Cont'd)

The replacement heads-down and heads-up graphics generation system procurement came to a decision point in June. The sole bid for a stroke/raster hybrid generation system was about twice what was expected. We decided to re-think the tradeoffs between raster flexibility and stroke resolution, and subsequently cancelled the solicitation. We plan to re-evaluate the issues and in all probability, select either raster or stroke capability solely.

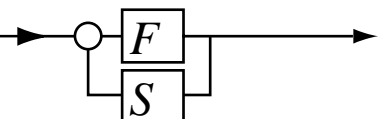
VMS REACTOR FAILURE:

In mid-November '90, we experienced a catastrophic failure of the multi-ton reactor winding that shunts electrical load during VMS motion-drive motor-generator (MG) system start-up. The VMS motion system was out of commission for 11 weeks, while the reactor was sent out for re-winding and repair, at a cost of \$100K. The entire MG control system has been greatly in need of rehab and upgrade for some years, so at that point, the Center Director re-programmed \$800K of Coff funds to implement this rehab of the system. Specification and design is underway, along with buying parts. System component replacements will take place during the December '91/January '92 shutdown.

BUILDING/PLANT INTEGRITY:

Several years ago, SimLab commissioned an in-depth study of the status of the Building N-243 plant; heating, ventilation and air-conditioning (HVAC) systems. The building was over 25 years old, much modified from its original intended purpose into a simulation laboratory. The result was a report and recommendation for a phased refurbishment of aging HVAC systems. This plan was submitted as a three-year phased Coff Rehab and Mod Project, and was implemented starting in FY91. Unfortunately, the building cooling tower didn't wait for this project and collapsed in the November '89 earthquake. Emergency earthquake recovery funds were made available to acquire a new cooling tower.

A comparable study has been started for Building 210 (the oldest building at Ames). A similar Coff plan is being proposed for this building, to refurbish the HVAC systems.



MAINTENANCE MANAGEMENT PROGRAM:

The recently initiated OAET facility maintenance management program is well established at ARC. This program is providing for maintenance and repair of non-ADP simulation hardware and equipment. In FY91, SimLab was funded for the maintenance and repair of the following:

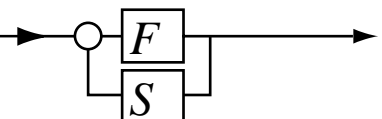
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|---|--------|
| • VMS Catenary (articulated support structure for cabling and hydraulic lines to cab) Refurbishment | \$140K |
| • VMS Switchgear (Motor Generator controls) | \$100K |
| • Reactor Repair (damage from November failure) | \$100K |
| • Electrical Drive System delta costs (+\$800 Coff) | \$200K |

In FY92, the total corrective/facility improvement budget of \$350K is allocated for next-phase VMS electrical drive system refurbishment costs.

HEADQUARTERS SIMULATION ASSESSMENT:

Considerable effort was expended in support of the HQ/OAET simulation assessment conducted across the OAET centers, and compared to U.S. industry, and the government (RAE) facilities in the United Kingdom.

A significant outcome of the HQ presentation on the Sim Assessment was the lifting of the restraint on acquisition of realtime mainframe computers for SimLab. This welcome news fed into the strategy planning process that was discussed earlier.



CIVIL SERVICE STAFF REORGANIZATION:

For many months during CY90, the management of the Flight Systems & Simulation Research Division reviewed the organization of the Civil Service staff in SimLab, with regard to the budget cuts, the support contractor staff layoff, and the retirement of the Chief of the Simulation Computers Branch. Over a six month period, a realignment of branches was studied and decided upon. Whereas there had been three branches, Experiments, Systems and Computers, Figure 1, it was decided to consolidate this staff into two branches, Experiments and Systems, as shown in Figure 2.

In May, 1991, Dave Jones, Chief of the Simulation Systems Branch, took the position of Chief of the Air Traffic Control Field Systems Office that was formed in this Division. David L. Astill, formerly Assistant Chief of the Simulation Experiments Branch, was selected as the new Branch Chief of the Simulation Systems Branch.

The new Division organization is shown in Figure 3.

FISCAL 92 PLANS:

In FY92, SimLab plans to acquire and Integrate the second VAX9000 mainframe computer, and acquire and integrate the heads-down/heads-up graphics generation system.

The refurbishment of the VMS MG control system will be completed.

A needed re-design and refurbishment of the VMS catenary cable-support mechanism will be accomplished during the year-end maintenance shutdown of VMS.

A low-level start-up of the refurbished Building 210 simulation laboratory will be initiated. This required code modification for fire suppression and seismic strengthening, is now complete. However, virtually no funds are available for the build-up of the lab to a fully functioning research simulation lab. This capability is considered critical to in-house Ames programs such as VSRA, RASCAL, and basic research that does not require the VMS.

Thus, efforts will be made to restore the lab capability at whatever funding level can be supported, over time.

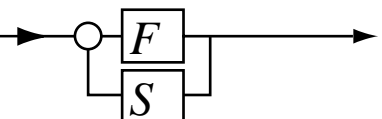


FIGURE 1

Flight Systems and Simulation Research Division Current Organization of Simulation Functions

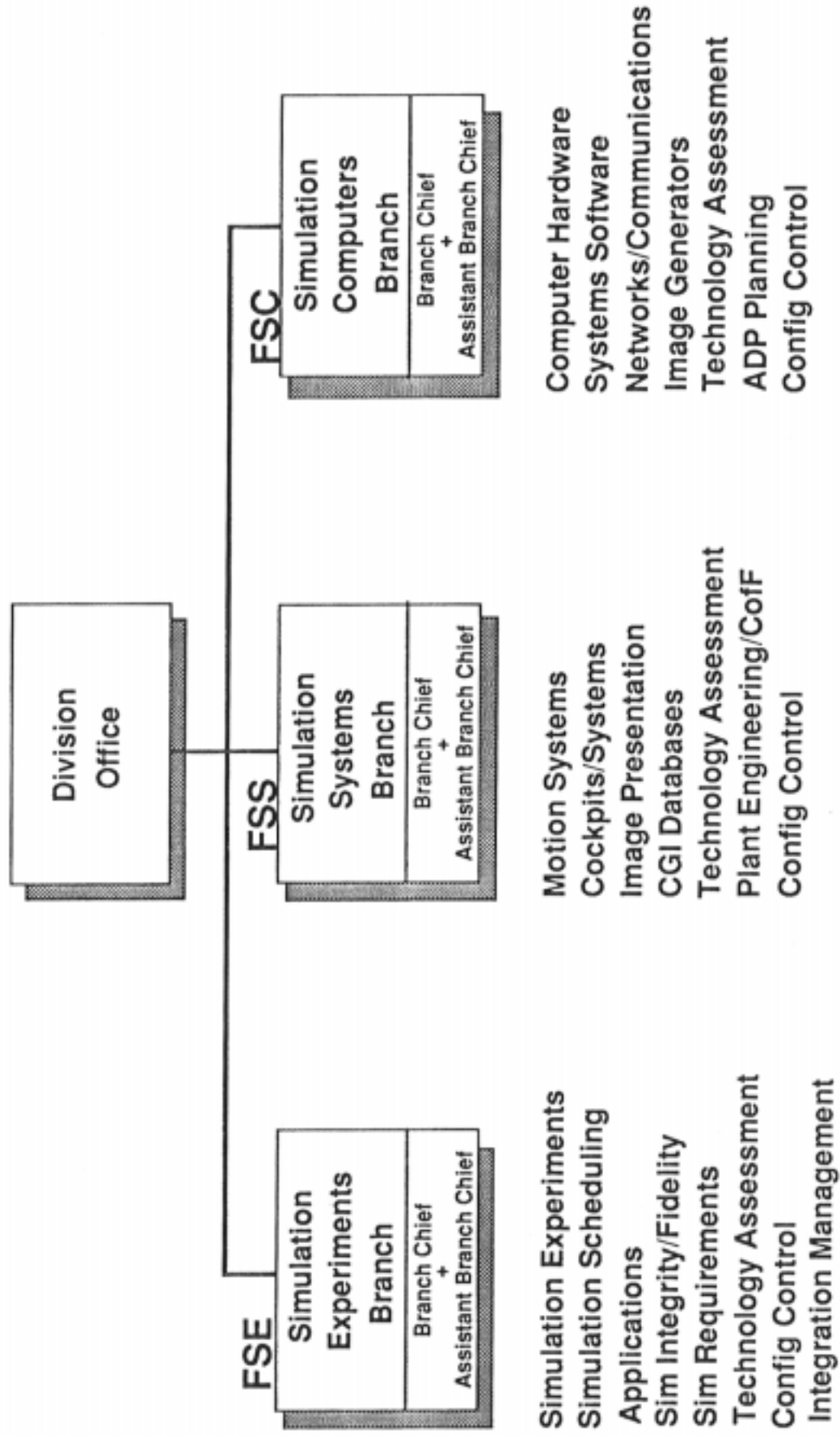


FIGURE 2

Flight Systems and Simulation Research Division Proposed Simulation Organization

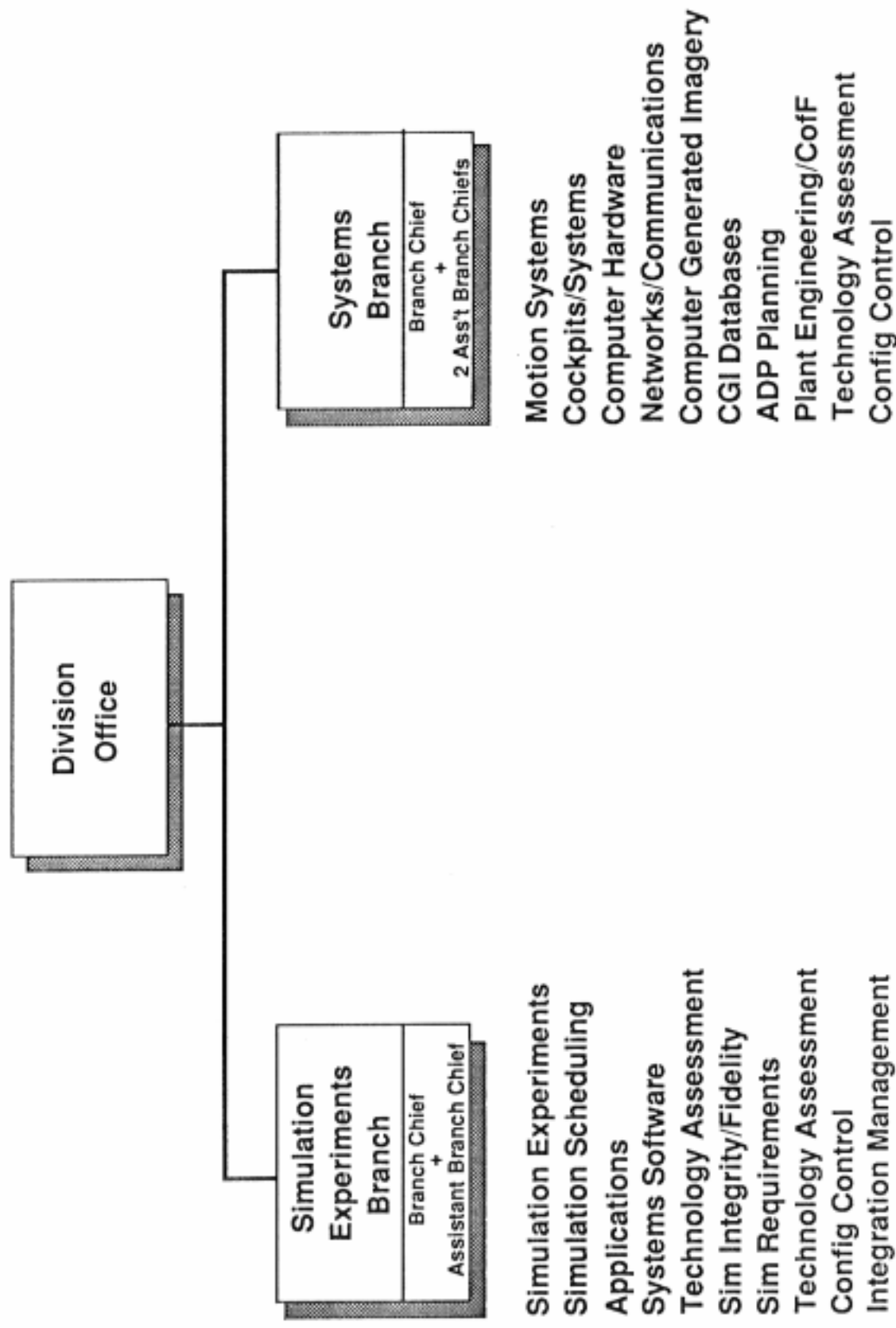


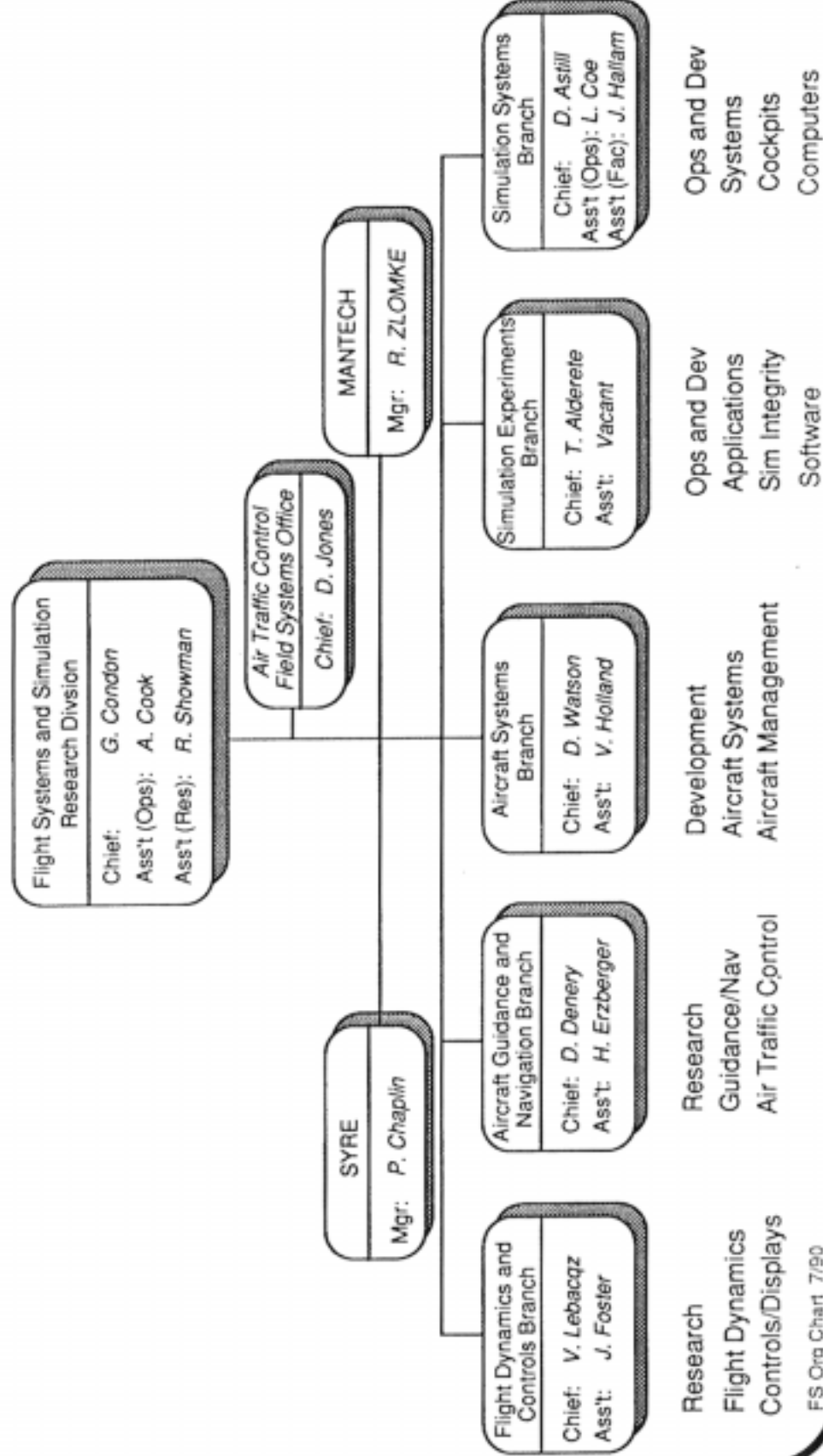
FIGURE 3

Flight Systems and Simulation Research Division

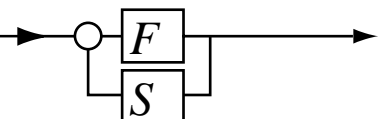
Organization

Roles and Missions:

- Research and Technology in Flight Dynamics, Stability & Control and Guidance & Navigation with Emphasis on Powered-Lift Aircraft
- Operation of Manned Flight Simulators, for US Government Use



SIMULATION SCHEDULE
&
SUMMARY OF INVESTIGATIONS

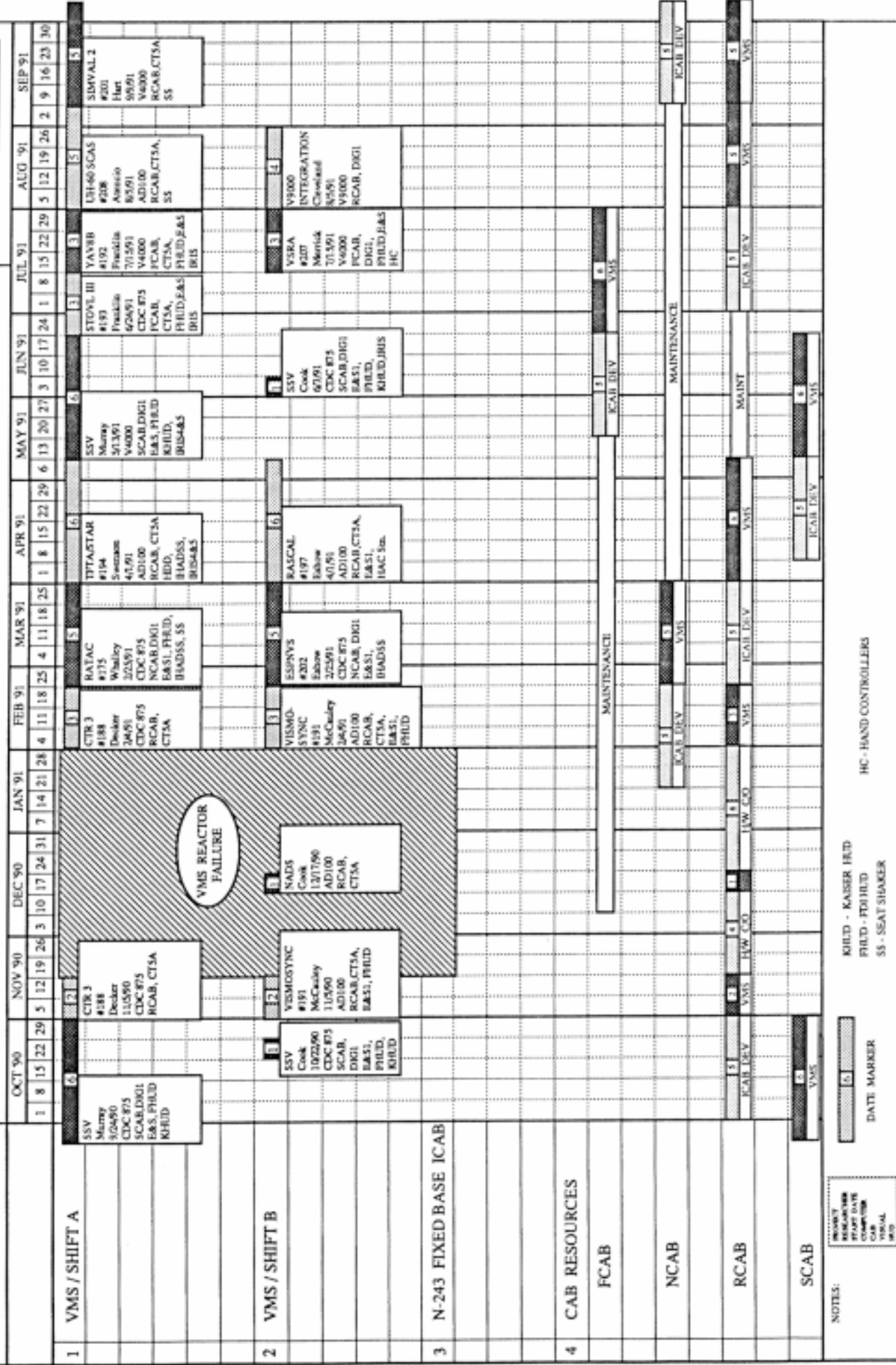


AMES RESEARCH CENTER

RESPONSIBILITY:	D. CHIN
Manager	
Approver	T. ALDERETE

FLIGHT SYSTEMS & SIMULATION RESEARCH DIVISION
VMS / ICAB SIMULATION SCHEDULE (FISCAL 91)

SCHEDULE DATES	
Original Approval	7/1/20
Last Change	
Status as of	



SIMULATION SCHEDULE - FY 91

SUMMARY

During FY 91, SimLab will conduct 14 simulation investigations on the VMS. This is down by at least 4 from previous operational capability, due to the current strategy to reduce operational levels to fund capability Integrity issues.

The reactor failure in November '90 cost 2-1/2 months of motion operations, however, the sims in progress at the time of the failure continued with fixed-base investigation, and finished the motion requirements after resumption of operations.

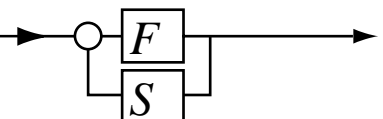
SHUTTLE ORBITER APPROACH & LANDING (SEP/OCT '90 - 6 WEEKS)

GOALS:

- Evaluate Drag Chute performance - various models
- Expand nose slatdown database
- Evaluate Nose Wheel Steering (NWS) Modifications
- Evaluate Autoland takeover
- Crew Training & Engineering Evaluations

RESULTS:

- 1464 Data Runs with 31 Astronaut Pilots
- The Drag Chute remains the single most effective improvement that can be made to the landing and deceleration capabilities of the orbiter
- Shuttle program ready to proceed with drag chute Detailed Test Objective (DTO)
- "The Drag Chute should be incorporated operationally as soon as possible".



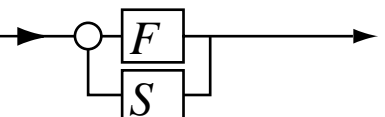
CIVIL TILT ROTOR (CTR) III
(NOV '90/FEB '91 - 5 WEEKS)

GOALS:

- Address operational and airworthiness issues for tilt-rotor class aircraft
- Examine potential task performance and workload improvements for the IMC steep approach task provided by a flight director or a flight path vector display

RESULTS:

- 500 data runs recorded by eight pilots
- Cooper-Harper pilot ratings confirm the strong influence of winds and turbulence on the IMC approach task with degradations of half to one full rating in moderate crosswinds.
- Approaches as steep as 15 degrees appear feasible with the use of display augmentation
- At 15 degrees, cockpit and windshield geometry become very important to the approach acceptability.



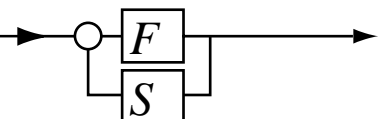
VISUAL/MOTION SYNCHRONY (NOV '90/FEB '91 - 5 WEEKS)

GOALS:

- Examine role of motion base in simulator-induced sickness
- Examine adaptation between multiple simulated flights with short inter-flight breaks

RESULTS:

- Due to the interruption in this experiment, and the use of less than appropriate pilots (Operation Desert Storm preempted originally scheduled pilots), it was not possible to obtain conclusive results for this experiment.
- However, much was learned relative to human instrumentation and data-gathering for future physiological measures of simulator sickness.
- Study to be continued in November '91.



NATIONAL ADVANCED DRIVING SIMULATOR (DECEMBER '90 - 1 WEEK)

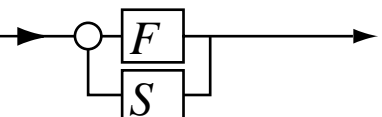
Large motion simulation requested by National Highway Traffic Safety Administration (NHTSA) of the Department of Transportation. Sim was conducted on VMS during period in which vertical motion was disabled car simulation did not require vertical motion!

GOALS:

- Provide data to support development of National Advanced Driving Simulator (NADS) which will be used for vehicle engineering and highway safety studies.
- Explore highest risk element of the design, i.e., large lateral and longitudinal motion.
- Simulate Daimler-Benz Driving Simulator limited motion system
- Assess design aspects relative to simulator sickness

RESULTS:

- Favorable evaluation of VMS/automobile fidelity from auto company engineers and Daimler-Benz simulation expert.
- NADS design better than limited motion hexapod from standpoint of both fidelity and SimSic issues
- Confirms requirement for large linear motion platform for NADS.



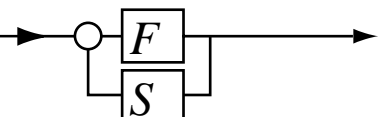
ROTORCRAFT AIR-TO-AIR COMBAT (RATAC) (FEB/MAR '91 - 5 WEEKS)

GOALS:

- Perform a broad survey of helicopter air-to-air combat maneuverability and agility issues
- Refine forward-flight pitch and roll handling qualities dynamic response criteria for forward flight contained in ADS-33C, "Handling Qualities Requirements for Military Rotorcraft".
- Assess abilities of AUTOMated MANeuvering target (AUTOMAN) as an aggressive air-to-air opponent.

RESULTS:

- A detailed assessment of the forward-flight air-to-air requirements in ADS-33C was performed for the first time.
- General agreement was seen with existing ADS-33C requirements.
- A pitch rate requirement of 70 deg/sec was indicated by data.
- Pilot commentary indicated that the AUTOMAN was an aggressive air-to-air opponent and proved itself satisfactory for this type of work.



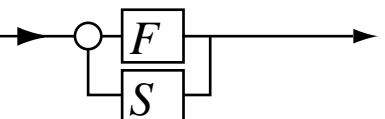
ENHANCED SYMBOLOGY FOR PILOT NIGHT VISION SYSTEM
(ESPNVS)
(FEB/MAR '91 - 5 WEEKS)

GOALS:

- Develop and validate an improved hover display drive law for the AH-64 Apache
- Demonstrate to the manufacturer and the US Army the potential improvements in handling qualities and operational effectiveness of using the new law versus the existing production law
- Transfer the design technique to the US helicopter industry for application to hover displays.

RESULTS:

- All 11 pilots judged the three alternative display laws to be superior to the production law both in workload and performance.
- Quantitative performance data confirm the pilots' perceptions
- Handling qualities improvements lead directly to improved mission effectiveness for the Apache in low-visibility hovering tasks.
- MDHC participants pursuing incorporation of the preferred law in the Longbow - details of the design methodology transferred to all three participating manufacturers.



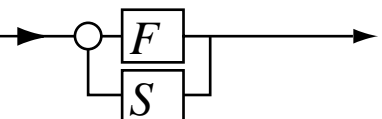
TERRAIN-FOLLOWING/TERRAIN AVOIDANCE (TFTA/STAR) (APRIL '91 - 6 WEEKS)

GOALS:

- Identify the requirements for a pilot-acceptable automated nap-of-the-earth rotorcraft guidance and control system
- Operational evaluation of guidance and display concepts to determine tracking performance for various flight and environmental conditions

RESULTS:

- The evaluation pilots were able to manually track the HMD guidance through various combinations of terrain, speeds, and weather representative of system use.
- The guidance can be followed with low pilot workload without detracting from his awareness of the outside world.
- The pilot is able to combine the guidance with his visual senses to optimize the mission success in varying weather/threat conditions.
- The computer-aiding system has matured through the extensive use of flight simulation
- Integration of the concept into the UH-60 STAR helicopter is proceeding towards flight test early in 1992.



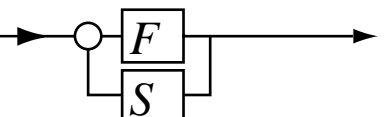
RASCAL
(APR '91 - 6 WEEKS)

GOALS:

- Investigate effects of failures that may occur in the fly-by-wire control system to be installed in the RASCAL UH-60 aircraft
- Determine the design goals for the servo control unit with regard to the size or rate of a control command fault that must be detected by an automatic monitor rather than by the safety pilot
- Specify monitors that would rapidly detect the unacceptable failures
- Evaluate the impact of the monitors on the research envelope of the aircraft by testing for nuisance trips

RESULTS:

- Monitor design goals of failure-rating are too restrictive to allow the most aggressive type maneuvers
- Nuisance trips too easy to induce with these monitors
- Frequency of nuisance trips may be reduced by relaxing the monitor design goals and reducing the likelihood that failures will reach the servo monitors.



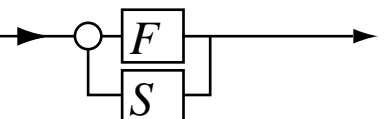
SHUTTLE ORBITER APPROACH LANDING (MAY/JUNE '91 - 6 WEEKS)

GOALS:

- Determine loads for STS-43 RTLS (242K GW, 1093 c.g.)
- Study derotation control for main tire peak loads
- Gather KSC tire spin-up and shoulder wear
- Study refinements for upcoming drag chute Detailed Test Objective (DTO)
- Crew training

RESULTS:

- 1820 data runs with 36 Astronaut/Pilots
- Preliminary results show that with smooth, slow derotations, loads for STS-43 are controllable and within limits.
- Significant tire wear expected at KSC
- Drag Chute DTO is ready to be flown



STOVL III
(JUN/JULY '91 - 3 WEEKS)

GOAL:

- Develop control system design criteria for STOVL fighter.

YAV8B
(JUL/AUG '91 - 3 WEEKS)

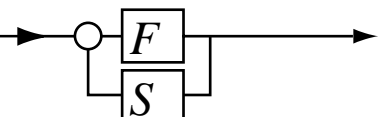
GOALS:

- Develop design criteria for thrust margins in ground effect
- Acquire Simulation/Flight comparisons for Harrier.

VSRA
(JUL/AUG '91 - 3 WEEKS)

GOALS:

- This sim is planned to occur concurrently with the VSRA flight tests at Ames/Moffett
- The combined flight test and simulation experiment is aimed at answering two questions:
 - Do the position and speed guidance concepts and their presentation on the displays assist during VFR approach and landing, either by reducing pilot workload, or improving precision?
 - Are the position and speed guidance concepts and the attitude information as presented on the displays, satisfactory for IFR approach and landing, and to what visibility minima?



UH-60 SCAS
(AUG/SEP /91 - 5 WEEKS)

GOALS:

- To develop and evaluate stability and control augmentation laws optimized for use with night vision goggles. Constraints are to stay within existing SCAS actuator rate and authority limits (safety implications), and use existing sensors (cost/complexity).

SIMVAL 2
(SEP/OCT '91 - 5 WEEKS)

GOALS:

- To develop quantitative criteria for assessing and improving the validity of ground-based simulation in general and the Ames' VMS in particular.
- Focus on the dynamic response of the motion system and its washout schemes, the visual system time delays, and the interactions between the two.
- Effects will be studied for helicopters performing hover and low speed tasks with roll and attitude command response types.

